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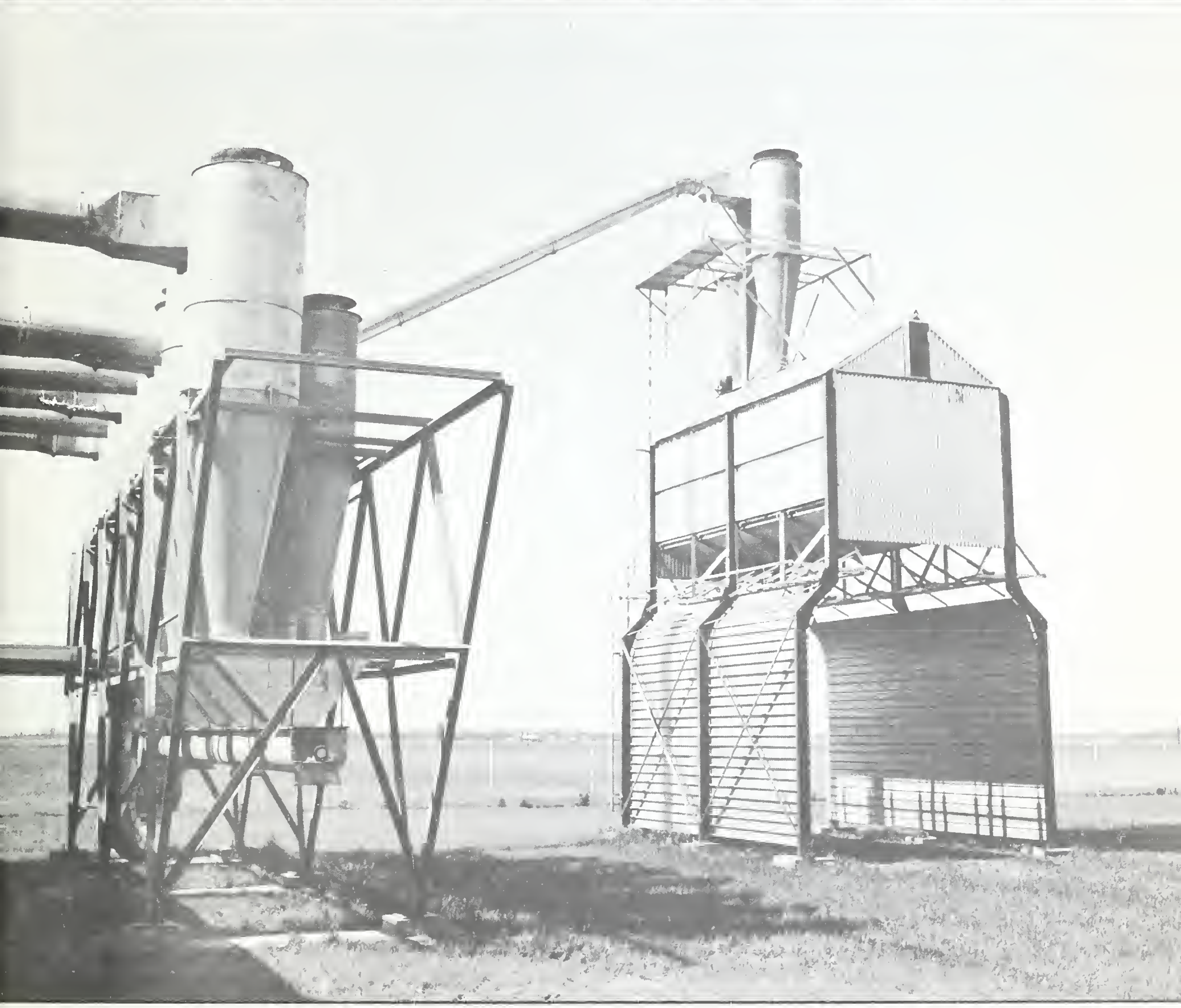
THE COST OF AIR POLLUTION CONTROL TO COTTON GINNERS



U.S. DEPARTMENT OF AGRICULTURE / ECONOMIC RESEARCH SERVICE / ERS-536

ABSTRACT

Enforcement at all gins of the strictest air pollution controls now in effect at some gins would require an investment of over $100 million. To meet these regulations, individual ginners would have to spend from nearly $24,000 to over $53,000, depending on plant size. The annual cost to the industry would be about $28.5 million. This could increase the average cost of ginning by as much as $2.23 per bale.

However, present regulations vary widely between States and even within some States. Although most compliance deadlines have passed, air pollution control boards, in view of the extreme seasonality of the ginning operation and continuing economic plight of most ginners, seem to have adopted a go-slow policy of enforcement.

Keywords: Air pollution, capital requirements, cost estimate, cotton ginning, economic impact, waste.

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SUMMARY

Under present and anticipated pollution control regulations, cotton gins will need to reduce air pollution. Estimates for the cost of installing cyclones (which remove particles from the air by centrifugal force) and in-line air filters, plus the costs of overhead storage hoppers and trucks for hauling, range from nearly $24,000 for a 6-bale per hour gin designed for machine-picked cotton to well over $53,000 for a plant capable of ginning 36 bales of stripper-harvested cotton per hour. If future air pollution regulations require all of the approximately 3,900 active gins to install this equipment, total investment cost would exceed $100 million.

Annual costs under these conditions, including depreciation, interest, taxes, insurance, repairs, extra energy, and hauling expenses, would exceed $28.5 million. This amounts to about $2.33 per bale, based on a 12.8-million-bale crop. For new plants, part of the investment costs would be offset by savings on the cost of incineration, piping, and cyclones which would otherwise have been used.

High-efficiency cyclones and various types of inline air filters, when properly sized and installed, handle various kinds of gin trash very effectively. Cyclones collect heavy trash from the outlets of centrifugal fans. Inline air filters can be installed in all condenser discharges to trap lint fly and dust. In installations where dust emissions are not a problem, lint fly can effectively be trapped by installing mesh wire screen or perforated metal over the condenser drums. This is significantly more economical than installing inline air filters. Gin trash, lint fly, and dust which is removed from the air discharges may be deposited through a dropper into another air line and moved to a single cyclone over a storage bin for final deposit.

The number of high pressure fan outlets requiring cyclones will vary from approximately 8 to 14, depending on the arrangement of the equipment and capacity in bales per hour. A low pressure vane-axial type fan is required for each condenser exhaust. Thus, a gin will have one of these fans for the main battery condenser, and usually one for the lint cleaner condensers behind each stand. Each of these outlets will normally exhaust into an inline air filter, unless conditions are such that the fine mesh covering on condenser drums will suffice. These vane-axial fans and inline filters will each number from 2 to 7, depending on the size of the gin.

Growers or ginners will probably absorb most of the cost increases resulting from the installation and use of air pollution control equipment. Cotton faces active competition in the fiber market from synthetics. Therefore, any attempt to pass on the cost increase to the consumer in the form of higher prices will risk losing more of cotton's share of the market to synthetics.

THE COST OF AIR POLLUTION CONTROL TO COTTON GINNERS

by Charles A. Wilmot, Zolon M. Looney, and Oliver L. McCaskill [1]

INTRODUCTION

During the cotton ginning process, pollutants consisting of lint, dust, leaf, and other trash, and smoke (when waste is burned) are emitted into the air. The degree of pollution depends on the condition of the seed cotton being ginned, and the gin plant. Dust-laden lint (lint fly) is emitted from condensers, and is particularly objectionable to gin employees and residents of the immediate area because it settles on electric lines, the gin yard, adjacent buildings, and adjacent trees and shrubbery. It not only causes a serious "housekeeping" problem, but also constitutes a major fire hazard. In addition, heavier foreign materials consisting of motes, leaf trash, sticks and stems, and burs are discharged from gins, creating a disposal problem.

The pollution problem is intensified because in the ginning operation, materials are handled almost exclusively by air. Seed cotton is unloaded from the hauling vehicle and moved into the building by suction. At several stages during processing it is reintroduced into an air line for drying and cleaning. It is moved by mechanical means only at the final stage of cleaning. The cotton is discharged from the last cleaning stage into an auger which distributes it to the successive feeders and gin stands. Any overflow from the distributor is again sucked up by air and redeposited into the distributor.

At the gin stand, lint is doffed from the saws by means of a high-speed brush or air blast and moved through the lint flue to the condenser by the air generated in the process. Here, the lint is condensed into a bat and doffed for pressing, while the air is exhausted by means of a high-volume, low-pressure fan. The seed, which has been separated from the lint by the saws, is conveyed by a belt, or auger, to a dropper which deposits it into a high-pressure air line for delivery to the seed house or truck. Trash from the various stages of cleaning is removed from the gin plant by air (fig. 1).

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TYPICAL GIN SYSTEM

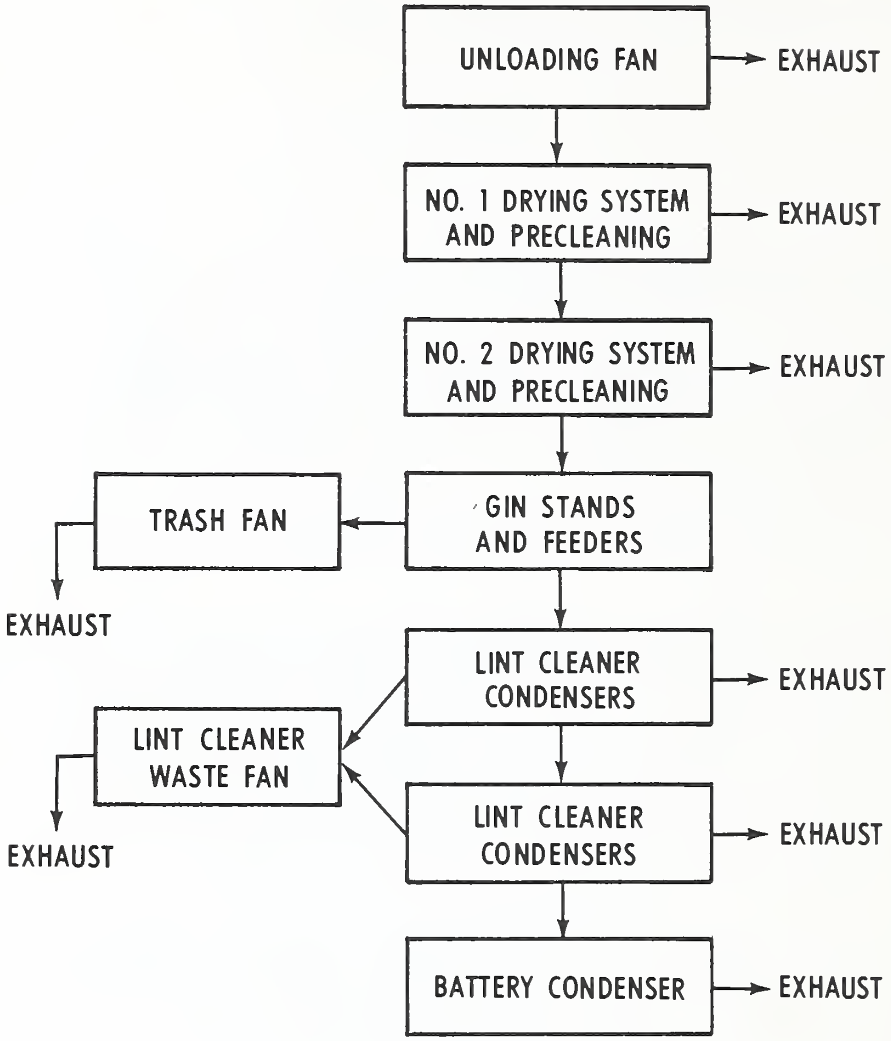


Figure 1

In some cases, fans are installed for this specific purpose; in others, the exhausts from fans installed primarily to perform other functions, such as drying, are also used to remove trash.

Traditionally, fine dust and lint fly from lint condenser exhausts have been discharged directly into the atmosphere or into rather crude, relatively ineffective "dust houses." Heavier foreign matter has been blown into bayous and other streams, lakes, or more often into open pits for burning. Thus, the air was polluted with dust, lint fly, and smoke. Bodies of water were contaminated with rotting organic material and insecticide and herbicide residues.

THE PROBLEM FACING GINNERS

Although wide variations occur about average data, the extent of the current air pollution problem at U.S. cotton gins has been roughly evaluated, based on recent statistics, as follows:

A. Estimated cotton production = 12.8 million bales (500 lbs. each)
B. Estimated number of gins = 3,900
C. Estimated burs, trash, dirt, lint, and moisture per bale:
    1. Machine picked (approx. 75 percent of crop) = 240 pounds
    2. Machine stripped (approx. 25 percent of crop) = 940 pounds

All foreign matter must be contended with as waste and disposed of in some manner. Although the bulk of it is coarse and does not contribute directly to air pollution, the past custom of burning such materials is part of the pollution problem.

Assuming that the average foreign matter escaping into the air from a "typical" U.S. gin plant is equal to 5 percent of the total foreign matter in machine-picked cotton, this would amount to 12 pounds foreign matter per bale, or 76,800 total tons, going into the air annually. 2/ The primary fire hazard and the main concentration of lint fly and other particulate matter is generally concentrated within a 1-mile radius of the gin plant, but some of the finer materials may be airborne for several miles.

2/ Allowable rates of emissions under controls range up to 3.5 pounds per hour per bale, based on process weight.

It is difficult to place a monetary estimate on the value of reducing air pollution by gins. However, the necessity for control must be recognized. For the ginner, it is a question of survival.

For most gins, air pollution control will mean the installation and operating expense of additional equipment. The gin operator must be able to determine as realistically as possible the costs he will incur in complying with antipollution laws. The purpose of this report is to provide the information needed by ginners in determining: (1) whether they can afford to comply with antipollution standards and (2) the most economical means of carrying out the necessary measures.

WHAT THE AIR POLLUTION REGULATIONS SAY

Air contaminants emitted from cotton gins are in two general categories--smoke and particulate matter. Smoke consists of small gas-borne and air-borne particles resulting from incomplete combustion, make up predominately, but not exclusively, of carbon ashes or other combustible material. Particulate matter is any material, except uncombined water, that exists in a finely divided form as a liquid or solid under standard conditions. 3/

Smoke

The density of smoke emissions is generally measured using the Ringelmann Chart--a chart published and described in the U.S. Bureau of Mines Information Circular 8333. Illustrated on this chart are graduated shades from gray to black, ranging from No. 1 (80 percent white and 20 percent black) to No. 5 (20 percent white and 80 percent black), for use in estimating the light obscuring capacity of smoke. The density reading of a smoke plume is made by placing the chart vertically with the stack to be observed and at 50 feet from the observer. Observation is made at right angles to the direction of the smoke travel at not less than 100 feet nor more than one-half mile away, using the sky as the background. Density is determined by matching the smoke shade with the corresponding shade on the chart. 4/

3/ Standard conditions defined as temperature of 68° F. and pressure of 14.7 pounds per square inch absolute.

4/ Density reading procedure taken from Mechanical Engineer's Handbook, Lionel S. Marks, Fourth Edition, McGraw-Hill Book Co., p. 1,156.

Open burning is prohibited in all cotton-producing States with the exception of specific areas in West Texas, where a high incidence of Verticillium Wilt prevents the return of gin waste to the land. Therefore, any continuous column of smoke emanating from the premises of a cotton gin probably originates from an approved incinerator. "Wigwam" or "Teepee" burners have been quite popular in the past, but do not now meet specifications without rather elaborate modifications. Air pollution control boards in most States discourage the use of any type of burner other than a multiple-chamber incinerator. 5/

General rules and regulations for most States specify a maximum permissible smoke density of Ringelmann No. 2. Specific regulations governing the density of smoke from an approved incinerator generally call for a limit of Ringelmann No. 1. 6/ Since legal burning of gin waste must be carried out in approved incinerators, this establishes a limit of Ringelmann No. 1 for smoke density at gins (table 1).

Particulates

Particulate emissions are generally determined from air samples collected at sampling ports in stacks or ducts using a "high-volume" air sampler. Emission limits of particulate matter are specified in process-weight tables. 7/

5/ A multiple-chamber incinerator is defined as "...any article, machine, equipment, or contrivance which is used for the reduction or destruction of solid, liquid, or gaseous waste by burning and consists of a series of 3 or more combustion chambers physically separated by refractory walls, interconnected by gas passages or ducts, and lined with refractories having a pyrometric core equivalent of at least 31, listed according to ASTM method C-24, and is designed for efficient combustion of the type and volume of material to be burned." Rules and Regulations for Air Quality Control, ch. 270-5-24, Ga. Dept. of Public Health, Mar. 13, 1972, p. 3.

6/ This level may be exceeded for very limited periods of time (ranging from 30 seconds to 6 minutes in any 60 consecutive minutes, depending on the State) for operations such as cleaning the fire box, changing equipment and removing ashes.

7/The measure of all materials introduced into the ginning process which may cause any discharge into the atmosphere.

Table 1--Summary of antipollution laws affecting cotton gins, by States, 1973 1/

State	Pollutant type	Allowable emissions 2/	Compliance date 3/	Supplementary clauses		
				Nuisance factor	Fugitive dust	Variance
Alabama......	Smoke	Ringelmann No. 1	9/15/74 4/	yes	--	yes
	Particulates	See table 2	9/15/74 4/	yes	yes	yes
Arizona......	Smoke	Ringelmann No. 1	3/29/73	no	--	yes
	Particulates	See table 2	3/29/73	no	yes	yes
Arkansas.....	Smoke	Ringelmann No. 1	1/30/73 5/	no	--	yes
	Particulates	6/	7/30/69	no	yes	yes
California...	Smoke	Ringelmann No. 1	1/1/74	yes	--	unspecified
	Particulates	See table 2	1/1/74	yes	yes	unspecified
Georgia......	Smoke	Ringelmann No. 1	6/1/73	yes	--	yes
	Particulates	See table 3	6/19/72	yes	yes	yes
Louisiana....	Smoke	Ringelmann No. 1	5/31/75	no	--	yes
	Particulates	See table 2	5/31/75	no	yes	yes
Mississippi..	Smoke	Ringelmann No. 2	12/1/74	yes	--	no
	Particulates	See table 2	12/1/74	yes	yes	no
Missouri.....	Smoke	Ringelmann No. 1 7/	12/31/71	no	--	yes
	Particulates	See table 2	10/3/71	no	yes	yes
New Mexico...	Smoke	Ringelmann No. 2	7/1/70	no	--	yes
	Particulates	No regulation	--	--	--	--
No. Carolina	Smoke	Ringelmann No. 1 8/	7/1/70	no	--	unspecified
	Particulates	See table 2	7/1/71	no	no	unspecified
Oklahoma.....	Smoke	Ringelmann No. 1	1/1/71	no	--	unspecified
	Particulates	See table 2	4/15/71 9/	no	yes	unspecified
So. Carolina	Smoke	Ringelmann No. 1	7/1/74	yes	--	yes
	Particulates	See table 3	7/1/74	yes	no	yes
Tennessee....	Smoke	Ringelmann No. 1	8/9/75	no	--	unspecified
	Particulates	See table 2	7/1/75	no	no	unspecified
Texas........	Smoke	Ringelmann No. 1	12/31/73 10/	yes	--	yes
	Particulates	See table 2 11/	2/15/73	yes	no	yes

See page 7 for footnotes.

Footnotes to table 1:

-- = None.

1/ Authors' interpretations of published air pollution rules and regulations governing ginning operations in the respective States.

2/ Burning gin waste must be carried out using an incinerator or approved burner, since open burning is now prohibited in all States except for certain areas of Texas with high incidence of Verticillium Wilt. Smoke emission rates in excess of Ringelmann limits specified are permitted temporarily during maintenance and repair of incineration equipment. In addition to Ringelmann limits, some States specify grain loading limits in exhaust gases as well. These States and their respective grain loading limits are:

> Missouri, Mississippi, Louisiana, New Mexico and California--not to exceed 0.2 (California --0.1) grains of particulate matter per standard dry cubic foot of exhaust gas corrected to 12 percent of carbon dioxide, by volume, for products of combustion. Alabama--not to exceed 0.4 pounds per 100 pounds of material charged. South Carolina--not to exceed 0.5 pounds per million BTU of heat inputs. Arizona--not to exceed 0.17 pounds per 1,000 pounds of gases corrected to 50 percent excess air and calculated as if no auxiliary fuel had been used.

3/ Compliance dates have been specified but are not being rigidly enforced in all States.

4/ Grace period of 1 year beyond this date has been extended to a few gins.

5/ Applies to new equipment. Limits of up to Ringelmann No. 2 permitted in equipment already installed and in operation on or before this date.

6/ Emission of particulate matter from incinerators and other equipment governed by specific dispersion formulae. However, alternative use of process-weight table (see table 2) may be requested by owner.

7/ Applies to incinerators. Limits of up to Ringelmann No. 2 permitted in conical-type, "teepee" burners.

8/ Applies to new equipment. Limits of up to Ringelmann No. 2 permitted from equipment already installed and in operation on or before this date.

9/ Grace period of 18 months beyond this date has been extended to existing installations.

10/ After this date, emissions cannot exceed Ringelmann No. 1, as indicated, from sources constructed after 1/31/72 and Ringelmann No. 1-1/2 from sources constructed on or before 1/31/72.

11/ Any person not wishing to be controlled by process-weight table may select an alternative method of control which the Executive Secretary of the Air Control Board finds will provide comparable emission control efficiency and measurement.

There are essentially five different process-weight schedules specified for cotton gins among the 13 cotton-producing States for which data were available. 8/ The most common schedule--that employed by Louisiana, Missouri, Arizona, Oklahoma, and North Carolina--provides for allowable emissions ranging from 2.58 to 92.70 pounds per hour for respective hourly inputs ranging from 1,000 to 6 million pounds (table 2). Allowable emission rates for Mississippi are identical to these rates up through the 60,000-pound input rate. At greater rates of input, emission limits in the Mississippi schedule become more relaxed, ranging up to 876 pounds at hourly inputs of 6 million pounds. Another process-weight table carrying a different set of allowable emission rates is used by Alabama, Tennessee, and Texas. Hourly emission rates for this table range from 1.60 pounds for inputs of 1,000 pounds to 252.80 pounds for 6 million pounds. The process-weight tables for Arkansas and California are identical and appear to be the most stringent, calling for hourly emission limits ranging from 2.25 to 62.30 pounds per respective hourly inputs ranging from 1,000 to 6 million pounds. Process-weight tables for Georgia and South Carolina are each based on hourly inputs in bales rather than pounds. Correspondingly, emission limits in pounds per hour are shown for 1-bale input intervals, ranging from 1 through 20 per hour in the Georgia schedule and from 4 through 16 per hour in the South Carolina schedule (table 3).

Particulate matter used in these measurements is obtained from air samples collected from sampling ports in flues and stacks. Other particulates emitted during ginning are referred to as "fugitive dust." This type of pollutant can evolve from any substance or material which is scattered by the wind or air. Generally, no specific emission limits are assigned to fugitive dust. Only good housekeeping practices and reasonable precautions are specified, such as the use of water spray or the paving of unpaved roadways, the covering of open-bodied vehicles when transporting materials likely to give rise to airborne dust and the installation and use of hoods, fans, and filters to enclose and vent the handling of dusty materials.

In most States, compliance deadlines have passed. However, air pollution control boards, recognizing the extreme seasonality of the ginning industry and the continuing economic plight of most ginners, have adopted a go-slow policy of enforcement. Compliance pressures are being felt by ginners located in densely populated areas while, in most States, ginners in more remote areas may be allowed to continue much as they have in the past until complaints are registered concerning their operations.

8/ To date no process-weight table has been established for cotton gins in New Mexico.

Table 2--Allowable rates of emissions for cotton gins based on process weight rates, by States, 1973 1/

Process weight rate in pounds per hour	Arizona Louisiana Missouri North Carolina Oklahoma 2/	Mississippi 3/	Alabama Tennessee Texas 4/	Arkansas California 5/
	Pounds per hour			
1,000	2.58	2.58	1.60	2.25
1,500	3.38	3.38	2.40	--
2,000	4.10	4.10	3.10	3.59
2,500	4.76	4.76	3.90	4.12
3,000	5.38	5.38	4.70	4.62
3,500	5.96	5.96	5.40	5.08
4,000	6.52	6.52	6.20	5.52
5,000	7.58	7.58	7.70	6.34
6,000	8.56	8.56	9.20	7.09
7,000	9.49	9.49	10.70	7.80
8,000	10.40	10.40	12.20	8.48
9,000	11.20	11.20	13.70	9.12
10,000	12.00	12.00	15.20	9.73
12,000	13.60	13.60	18.20	10.90
14,000	15.10	15.10	21.20	12.00
16,000	16.50	16.50	24.20	13.03
18,000	17.90	17.90	27.20	14.02
20,000	19.20	19.20	30.10	14.99
30,000	25.20	25.20	44.90	19.24
40,000	30.50	30.50	59.70	23.00
50,000	35.40	35.40	64.00	26.41
60,000	40.00	40.00	67.40	29.60
70,000	41.30	44.40	70.50	30.57
80,000	42.50	48.60	73.20	31.19
90,000	43.60	52.50	75.70	31.82
100,000	44.60	56.40	78.10	32.35
120,000	46.30	63.70	82.25	33.28
140,000	47.80	70.60	86.00	34.15
150,000	48.44	--	87.70	34.53
160,000	49.00	77.30	89.40	34.85
200,000	51.20	89.70	95.20	36.11
250,000	53.55	--	101.50	37.48
500,000	60.93	--	123.90	41.87
1,000,000	69.00	264.00	151.20	46.72
2,000,000	77.60	420.00	184.40	52.28
6,000,000	92.70	876.00	252.80	62.30

See page 10 for footnotes.

Footnotes to table 2:

-- = Not specified.
Note: Interpolating equations: E = rate of emission in pounds per hour.
p = process weight rate in tons per hour.

1/ Information furnished by Pollution Control Boards of various States.
2/ $E = 4.10\ (p^{0.67})$ for process weight rates up to 60,000 pounds/hour.
$E = 55.0\ (p^{0.11})-40$ for process weight rates in excess of 60,000 pounds/hour.
3/ $E = 4.10\ (p^{0.67})$ for all process weight rates.
4/ $E = 3.12\ (p^{0.985})$ for process weight rates up to 40,000 pounds/hour.
$E = 25.4\ (p^{0.287})$ for process weight rates in excess of 40,000 pounds/hour.
5/ $E = 3.59\ (p^{0.62})$ for process weight rates up to 60,000 pounds/hour.
$E = 17.31\ (p^{0.16})$ for process weight rates in excess of 60,000 pounds/hour.

Complete descriptions of commercially available pollution control equipment and air-handling specifications are given in the appendix.

INVESTMENT COSTS FOR AIR POLLUTION CONTROL

Various Size Plants

Since air pollution control regulations vary from State to State, and even within States, investment costs necessary to meet these requirements will also vary. Based on estimates from three firms engaged in designing and installing air pollution control equipment for cotton gins, installation costs were developed for plants ranging in capacity from 6 to 36 bales per hour and for two methods of harvest (table 4). Costs range from $23,775 for a 6-bale gin equipped for machine-picked cotton to $53,480 for a 36-bale gin equipped for machine-stripped cotton. These estimates represent the installed costs of properly sized, small-diameter cyclones, filters, and elevated storage hoppers, together with the purchase price of trucks for hauling. These installations will meet regulations in States with the strictest controls specified at the present time. Also, they will probably meet any minimum requirements in the near future and be compatible with any more stringent systems which may be required later. For ginners presently situated so that alternative systems, or systems including only part of the specified equipment, would enable them to comply with regulations under which they are operating, investment costs would be lower than these estimates.

Table 3--Allowable rates of emission for cotton gins based on production rate, by States, 1973

Production rate in bales per hour	Georgia	South Carolina
	Pounds per hour	
1	7.00	--
2	9.90	--
3	12.12	--
4	14.00	12.30
5	15.65	14.40
6	17.15	16.20
7	18.52	18.00
8	19.80	19.50
9	21.00	21.20
10	22.14	22.80
11	23.22	24.20
12	24.25	25.80
13	25.24	27.10
14	26.19	28.50
15	27.11	29.90
16	28.00	31.20
17	28.86	--
18	29.69	--
19	30.51	--
20	31.30	--

-- = Not specified.

Table 4--Estimated investment costs for air pollution control equipment for cotton gins with hourly capacities of 6 to 36 bales and for two methods of harvest, 1973 1/

Gin size in bales per hour	Machine-picking	Machine-stripping
	Dollars	
6	23,775	24,955
8	25,585	26,810
10	26,405	27,840
12	27,275	28,940
16	35,950	37,970
18	36,030	38,040
20	37,615	39,985
24	38,560	41,665
30	47,415	49,820
36	50,990	53,480

1/ Includes cyclones, filters, dump house, and all installation costs and dump truck for hauling

The Industry

Gin batteries vary in capacity from less than 6 bales to 36 bales per hour (table 5). However, as late as 1970, almost two-thirds of all batteries in the United States had hourly capacities of 8 bales or less. Well over half the batteries in the Southeast, compared with about 40 percent of those in the Midsouth, had capacities of 6 bales or less. In the Southwest and West, relatively few gin batteries had capacities below 7 bales per hour. In the Southwest, the 7-8 bale per hour group had the largest number of plants, while in the Far West, the 9-10 bale batteries constituted the modal group.

The Environmental Protection Agency may eventually set minimum restrictions for all gins. If these regulations should be strict enough to require cyclones on all air discharge lines and inline filters on all condenser exhausts, and ban all burning so that waste would have to be hauled, the total investment in this equipment would be enormous.

Table 5--Distribution of gin batteries by capacity in bales per hour for each State, region, and United States, 1970

State and region	Capacity in bales per hour									
	6 or below	7 and 8	9 and 10	11-13	14-17	18	19-21	22-25	36	Total 1/
	No. of gin batteries									
North Carolina...	89	16	--	5	--	1	--	--	--	111
South Carolina...	119	45	4	20	5	1	--	--	--	194
Georgia..........	106	64	6	21	3	3	--	--	--	203
Alabama..........	153	72	5	25	8	--	1	--	--	264
Southeast......	467	197	15	71	16	5	1	--	--	772
Mississippi......	201	161	23	61	22	28	1	6	--	503
Tennessee........	142	49	3	12	1	1	--	--	--	208
Missouri.........	54	43	7	10	1	1	--	--	--	116
Arkansas.........	216	135	23	29	8	8	--	2	--	421
Louisiana........	51	54	17	21	4	8	2	2	--	159
Midsouth.......	664	442	73	133	36	46	3	10	--	1,407
Texas............	154	467	294	146	71	25	10	7	--	1,174
Oklahoma.........	44	43	17	17	7	3	2	--	--	133
Southwest......	198	510	311	163	78	28	12	7	--	1,307
New Mexico.......	12	22	6	8	2	--	--	--	--	50
Arizona..........	2	27	61	13	3	7	--	--	--	113
California.......	--	48	115	49	25	8	2	10	1	258
West...........	14	97	182	70	30	15	2	10	1	421
Total............	1,343	1,246	581	437	160	94	18	27	1	3,907

-- = None.

1/ Totals do not agree with census figures because both active gins and those idle gins considered likely to operate again are included here.

Based on these requirements and prices cited earlier in this report, the total investment in this equipment for all gins in existence in 1970 would exceed $100 million (table 6). In terms of geographic areas, this could amount to $36 million in both the Midsouth and Southwest, exceed $19 million in the Southeast, and approach $12 million in the Far West.

To bring existing gins up to these standards of control, the required investment would average approximately $26,500 per gin. For new plants being built in the future, part of this increased investment would be offset by savings on costs of incinerator and other disposal equipment which would otherwise have been used.

TOTAL ANNUAL COST AND COST PER BALE

If all gins operating in the United States were compelled to install cyclones on all fan exhausts, inline filters on all condenser exhausts, and a secondary collecting system, and haul the accumulated trash to an approved site away from the plant, the resulting costs would exceed $28.5 million per year (table 7). This includes hauling expense and a reasonable allowance for depreciation, interest on investment, taxes, insurance, repairs, and extra energy required. With a 12.8-million-bale crop, the extra cost would be about $2.23 a bale, adding 10 to 15 percent to the cost of ginning. For individual gins installing these items, the increased per bale cost would vary depending on number of bales ginned.

THE IMPLICATIONS: FEWER GINS, HIGHER COSTS

While cotton acreage and production have been declining generally, older, low-capacity gins are being replaced by fewer, higher-capacity plants. The trend to fewer plants could be accelerated by imposed air pollution control regulations. The cost of installing equipment necessary to enable these older firms to comply with these regulations may be prohibitive for many ginners. Other ginners with inadequate volumes, already facing uncertain futures, may elect to cease operations rather than make even moderate outlays for new pollution control equipment. If these ginners did not have to invest in such equipment, they could continue to operate for several years, providing at least some employment to local residents and convenient service to nearby growers.

Table 6--Total investment required for complete air pollution control for all cotton gins, by State and region, and by gin capacity 1/

State and region	Capacity in bales per hour									
	6 or below	7 and 8	9 and 10	11-13	14-17	18	19-21	22-25	36	Total
					1,000 dollars					
North Carolina...	2,116	409	--	136	--	36	--	--	--	2,697
South Carolina...	2,829	1,151	106	546	180	36	--	--	--	4,848
Georgia..........	2,520	1,637	158	573	108	108	--	--	--	5,104
Alabama..........	3,638	1,842	132	682	288	--	38	--	--	6,620
Southeast......	11,103	5,039	396	1,937	576	180	38	--	--	19,269
Mississippi......	4,779	4,119	607	1,664	791	1,009	38	231	--	13,238
Tennessee........	3,376	1,254	79	327	36	36	--	--	--	5,108
Missouri.........	1,284	1,100	185	273	36	36	--	--	--	2,914
Arkansas.........	5,135	3,454	607	791	288	288	--	77	--	10,640
Louisiana........	1,213	1,382	449	573	144	288	75	77	--	4,201
Midsouth.......	15,787	11,309	1,927	3,628	1,295	1,657	113	385	--	36,101
Texas............	3,807	12,406	8,101	4,177	2,667	941	395	287	--	32,781
Oklahoma.........	1,098	1,153	473	492	266	114	80	--	--	3,676
Southwest......	4,905	13,559	8,574	4,669	2,933	1,055	475	287	--	36,457
New Mexico......	290	571	161	222	73	--	--	--	--	1,317
Arizona..........	48	691	1,611	355	108	252	--	--	--	3,065
California......	--	1,228	3,037	1,336	899	288	75	386	51	7,300
West...........	338	2,490	4,809	1,913	1,080	540	75	386	51	11,682
Total...........	32,133	32,397	15,706	12,147	5,884	3,432	701	1,058	51	103,509

-- = None.

1/ Includes cyclone filters, dump house, and all installation costs and dump truck for hauling.

Table 7--Total estimated annual cost and cost per bale to the cotton ginning industry for compliance with air pollution control requirements

Item	Basis for determination	Amount
		Dollars
Depreciation	7 percent of $103,509,000 investment	7,245,630.00
Interest on investment	8 percent of one-half of investment	4,140,360.00
Taxes 1/	0.6 of 1 percent of investment	621,054.00
Insurance 1/	0.4 of 1 percent of investment	414,036.00
Repairs	5.5 percent of investment (IRS guidelines)	5,692,995.00
Energy 2/	2.2 kwh per bale @ 3¢ per kwh for 12,800,000 bales	844,800.00
Hauling trash 3/	75¢ per bale estimated	9,600,000.00
Total		28,558,875.00
Cost per bale	12,800,000 bales	2.23

1/ Approximate ratios of taxes and insurance to total investment for model gins from Economic Models for Cotton Ginning, Agr. Econ. Rpt. No. 214, U.S. Dept. Agr., Econ. Res. Serv., Oct. 1971.

2/ Based on average power required for trash fans.

3/ Includes labor and truck operating expenses.

In many of the small agricultural communities across the Cotton Belt, the only industry is the cotton gin or some other processing plant for agricultural products. Employment provided by cotton ginning is highly seasonal. However, opportunities for even this part-time work would be lost or reduced if some gins were forced to remain idle. This would have an adverse effect not only on the workers, but on local businesses as well.

For the short term, replacement of smaller, more dispersed gins with fewer plants of higher capacity would add to growers' costs by forcing longer hauls for seed cotton. Over-the-highway hauling of seed cotton for longer distances would tend to result in higher ownership and operating costs for more expensive hauling equipment. But in the long run, as the centrally located, high capacity replacement gins achieve adequate volumes, economies of scale associated with such plants would more than offset this additional expense. 9/ Also, operators of these larger plants, by processing more bales at one location, would be in a better position to take advantage of technological advances designed to reduce labor, power, and other operating costs.

For any given ginning operation, the installation of air pollution control equipment will increase ginning cost. This cost can be borne by growers or ginners in the form of reduced net returns, or passed on to the consumer in the form of higher prices. In the absence of competition from other fibers, it would be logical to assume that a processing cost increase resulting from the installation and use of air pollution control equipment would be passed on to the ultimate consumer. However, considering the inroads which synthetics have carved into cotton's markets over the past decade, any proposal to increase the relative selling price for cotton and, thus, risk losing more of cotton's share of the fiber market to synthetics, is likely to meet stiff resistance. Therefore, in the long run, growers or ginners may be expected to absorb most of this added cost.

9/ Looney, Zolon M., and Wilmot, Charles A. Economic Models for Cotton Ginning, Agr. Econ. Rpt. No. 214, U.S. Dept. Agr., Econ. Res. Serv., Washington, D.C., Oct. 1971

APPENDIX

For handling various kinds of gin trash, several types of equipment are available which, when properly sized and installed, are very effective. 1/ Principal among these are high-efficiency cyclones and various types of inline filters.

Equipment Available for Handling Waste

Cyclones

The cyclone is the most widely used dust and trash collector in the industry. It operates on the principle of centrifugal separation of particulates and air. Efficiency is determined by its ratio of radial settling velocity to the velocity under the action of gravity--the smaller the diameter, the greater the separation factor. 2/ Hence the "low-efficiency" classification for larger conventional-type cyclones still in use at many of the older gin plants and the "high-efficiency" classification for the newer, small-diameter cyclones. As the older, low-efficiency cyclones wear out, or improved residue collection efficiency is required, they are replaced with small-diameter units.

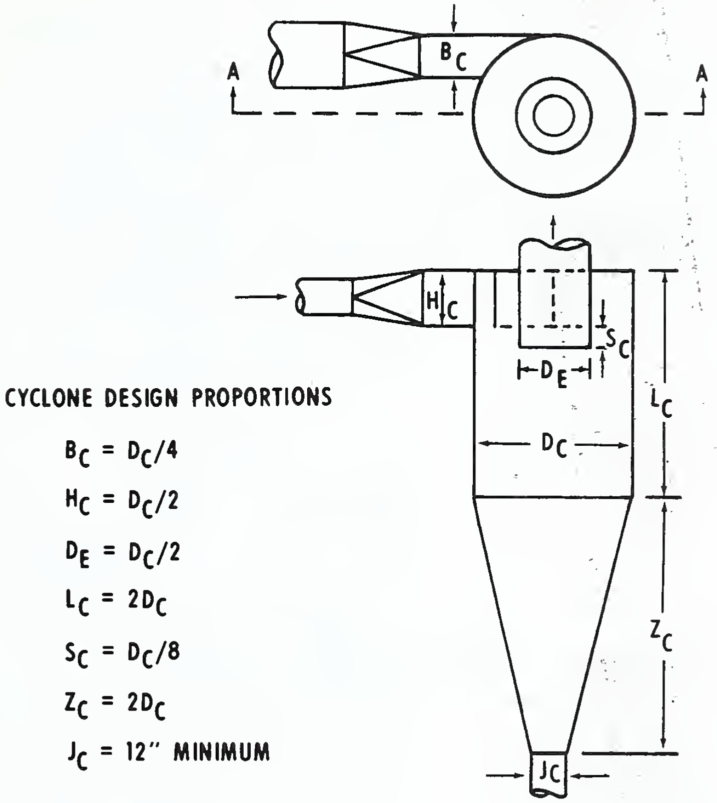
High-efficiency cyclones operate with a back-pressure of from 4 to 5 inches of water. Relative dimensions for a small-diameter cyclone are critical for satisfactory operation (app. fig. 1). Also, sizes and arrangements must be tailored to each specific ginning installation (app. figs. 2 and 3 and app. table 1).

Several variables are involved in determining the optimum cyclone system, including the volume of air to be handled. In general, low-volume fans will require only a single cyclone installation. As the volume of air is increased, double parallel mounted or quadruple parallel mounted cyclones will be required to ensure acceptable efficiency levels and keep sizes within practical limits. A 34-inch diameter is considered optimum for high-efficiency cyclones. Fan capability in overcoming pressure resistance is also important in cyclone sizing. An air inlet velocity of approximately 3,000 ft/min is required to ensure efficient removal of trash and dust. The calculated pressure drop for cyclones designed for an inlet air velocity of 3,000 ft/min is 4.3 inches of water. This is within the normal operational limits of straight blade centrifugal fans. The type of trash being collected and method of handling collected waste will also have some bearing on the arrangement selected.

1/ Handbook for Cotton Ginners, Agriculture Handbook No. 260, U.S. Dept. Agr., Agr. Res. Serv., Feb. 1964.

2/ Mechanical Engineers' Handbook, Fourth Edition, p. 1,670.

RELATIVE DIMENSIONS FOR SMALL DIAMETER CYCLONE DESIGN



CYCLONE DESIGN PROPORTIONS

$B_C = D_C/4$

$H_C = D_C/2$

$D_E = D_C/2$

$L_C = 2D_C$

$S_C = D_C/8$

$Z_C = 2D_C$

J_C = 12" MINIMUM

Figure A-1

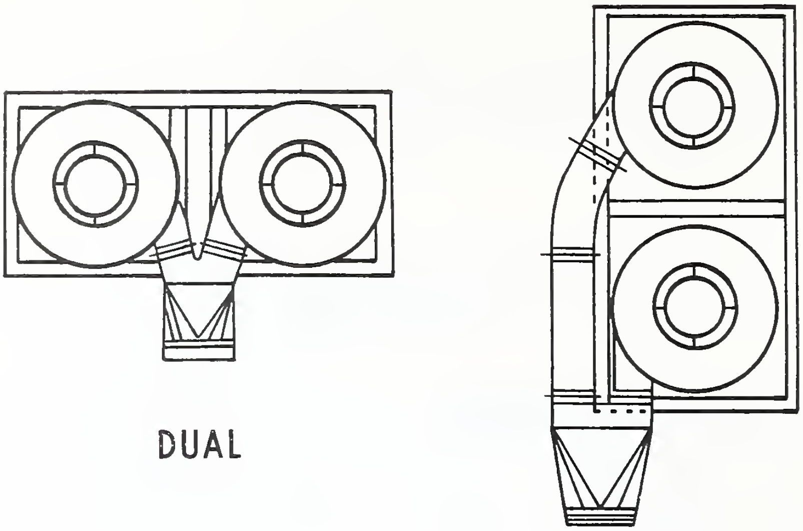
Space and height limitations will affect the choice of a multiple mount. A 4-foot diameter cyclone would be a minimum of 17 feet high (8-foot body, 8-foot cone, and at least 1 foot of the clean air exit pipe), whereas a 2-foot diameter cyclone would be only 9 feet high. The higher efficiency of the smaller diameter cyclones is an important consideration in the selection of multiple units.

In a positive pressure system where the cyclone discharges into an air line, a dropper is essential. For cyclones discharging into screw conveyors, sufficient conveyor size and speed should be provided to prevent stoppages. When mounted beneath trash collecting cyclones, most conveyors should be equipped with a hopper to accommodate temporary overloads.

High-efficiency cyclones cannot be used with vane-axial or propeller-axial (clean air) fans normally used on condenser exhausts.

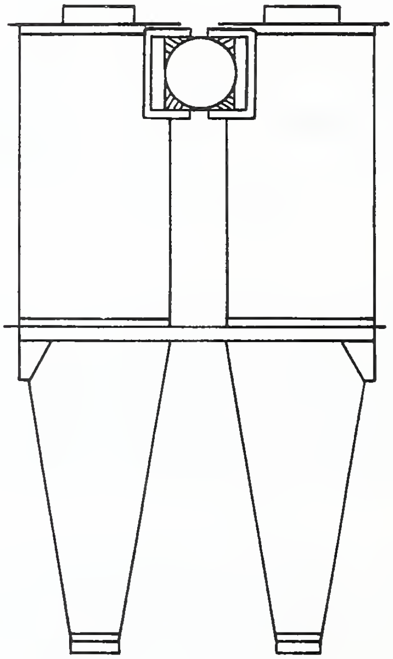
DUAL ARRANGEMENT OF CYCLONES

TOP VIEW



DUAL

TANDEM

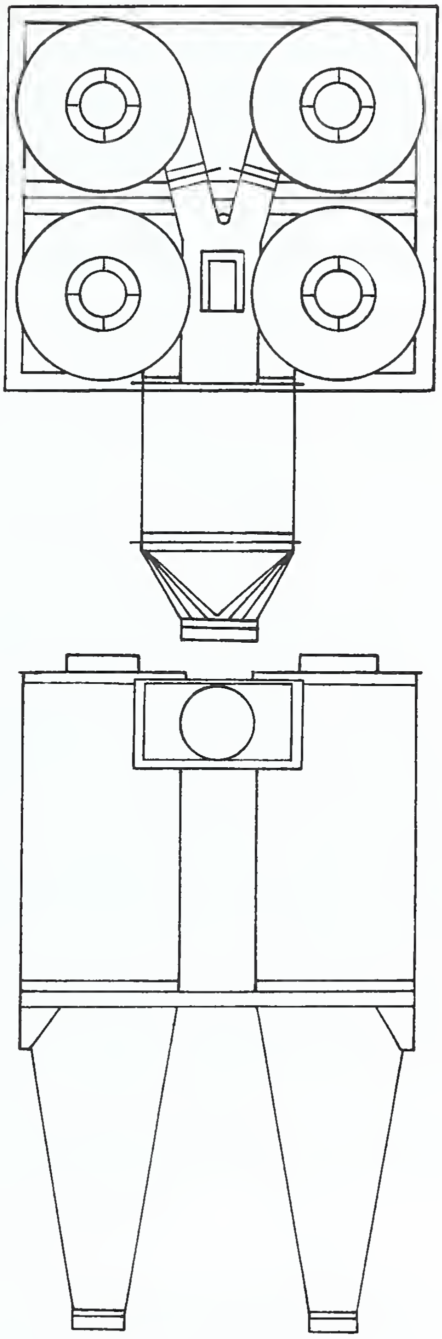


FRONT VIEW

Figure A-2

QUAD ARRANGEMENT OF CYCLONES

TOP VIEW



FRONT VIEW

Figure A-3

Table A-1--Dimensions and inlets for single, double, and quadruple cyclone installations under normal ginning conditions 1/

Air entering cyclone	Cyclone dimensions								
	Single			Double			Quadruple		
	Diam. Dc	Height: Lc+Zc	Inlet Bc x Hc	Diam. Dc	Height: LC+Zc	Inlet Bc x Hc	Diam. Dc	Height: Lc+Zc	Inlet Bc x Hc
Ft^3/min	In.	Ft.	In.	In.	Ft.	In.	In.	Ft.	In.
666	16	5	4 x 8	--	--	--	--	--	--
1,042	20	7	5 x 10	--	--	--	--	--	--
1,500	24	8	6 x 12	--	--	--	--	--	--
2,042	28	9	7 x 14	--	--	--	--	--	--
2,664	32	11	8 x 16	--	--	--	--	--	--
3,000	34	11	9 x 17	24	8	6 x 12	17	6	4 x 9
4,000	39	13	10 x 20	28	9	7 x 14	20	7	5 x 10
5,000	44	15	11 x 22	31	10	8 x 16	22	7	6 x 11
6,000	48	16	12 x 24	34	11	9 x 17	24	8	6 x 12
7,000	--	--	--	37	12	9 x 18	26	9	7 x 13
8,000	--	--	--	40	13	10 x 20	28	9	7 x 14
9,000	--	--	--	42	14	10 x 21	29	10	7 x 15
10,000	--	--	--	44	15	11 x 22	31	10	8 x 15
11,000	--	--	--	46	15	11 x 23	32	11	8 x 16
12,000	--	--	--	48	16	12 x 24	34	11	9 x 17

Note: Only sizes above the lines are recommended for gin installation.

1/ Handbook for Cotton Ginners, Agriculture Handbook No. 260, U.S. Dept. Agr., Agr. Res. Serv., Feb. 1964.

Filters

Filters may be installed to collect lint fly and small amounts of dust on low-pressure, high-volume air discharges following condensers. These may be of fixed screen or revolving screen design. [3] Essentially, a filter of this type consists of a fine mesh filtering screen mounted in an enclosed housing. The screen may be of stainless steel or monel batting cloth with about 50 percent open area. It operates with continuous sweeping action or on a collecting-cleaning cycle. Foreign matter such as lint fly and leaf trash accumulates on the screen surface during the collecting sequence and acts as a filter to catch finer dust particles.

Three basic types of inline air filters are available to ginners. One type has a fixed concave screen in the air line and a revolving wiping brush (app. fig. 4). Another filter has a screen covered, revolving drum with a fixed wiping brush similar in design to conventional lint condensers (app. fig. 5). The third is a round filter with a fixed, flat screen and a radial wiping arm (app. fig. 6).

All of these filters can be installed to operate either with a continuous wiping action or with an automatic "start and stop" cleaning sequence. The latter is accomplished by a diaphragm-actuated, pressure-differential switch on the motor (app. fig. 7). This switch must be set to engage at a lower differential pressure than the maximum allowable for the particular system involved. It is difficult to predict the exact maximum back-pressure that a particular system will operate satisfactorily against, because this will vary with the type of exhaust fan employed. Condenser exhaust systems employing vane-axial fans can usually withstand an additional back-pressure of 1 to 1-1/2 inches of water, while propeller-axial fan systems operate satisfactorily against 1/2 to 3/4 inch of water. Individual manufacturers' specifications must be followed closely to ensure proper operation of the inline filter. Final adjustments of the differential-pressure switch should be made in the field under actual operating conditions. This system is more expensive and somewhat less trouble-free than those with continuous wiping action, but is more efficient in trapping dust along with the lint fly.

For a filter to operate properly, it must be sized correctly (app. table 2). For a given air volume, the efficiency of a filter varies directly with its size.

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[3] Baker, Roy V., and Parnell, Calvin B., Jr. Three Types of Condenser Filters for Fly Lint and Dust Control at Cotton Gins, ARS 42-192, U.S. Dept. Agr., Agr. Res. Serv., Sept. 1971.

FIXED SCREEN INLINE FILTER WITH REVOLVING WIPING BRUSH

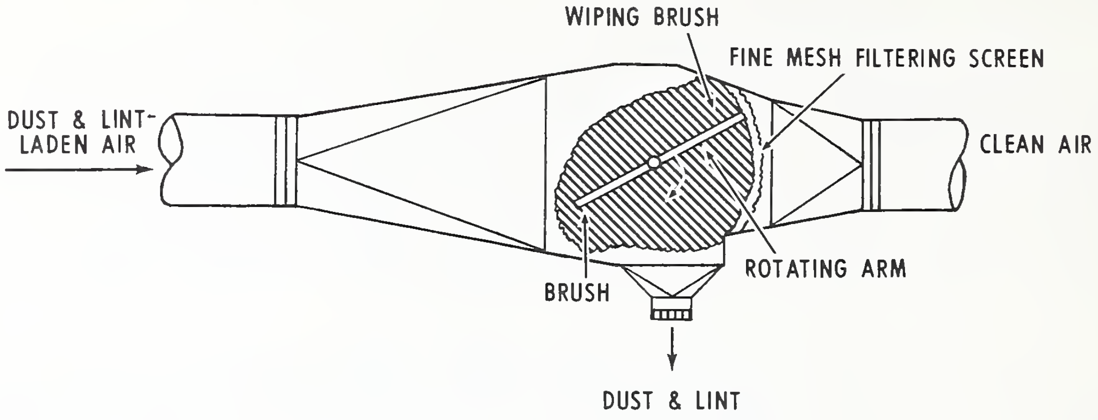

Figure A-4

REVOLVING SCREEN INLINE FILTER WITH FIXED WIPING BRUSH

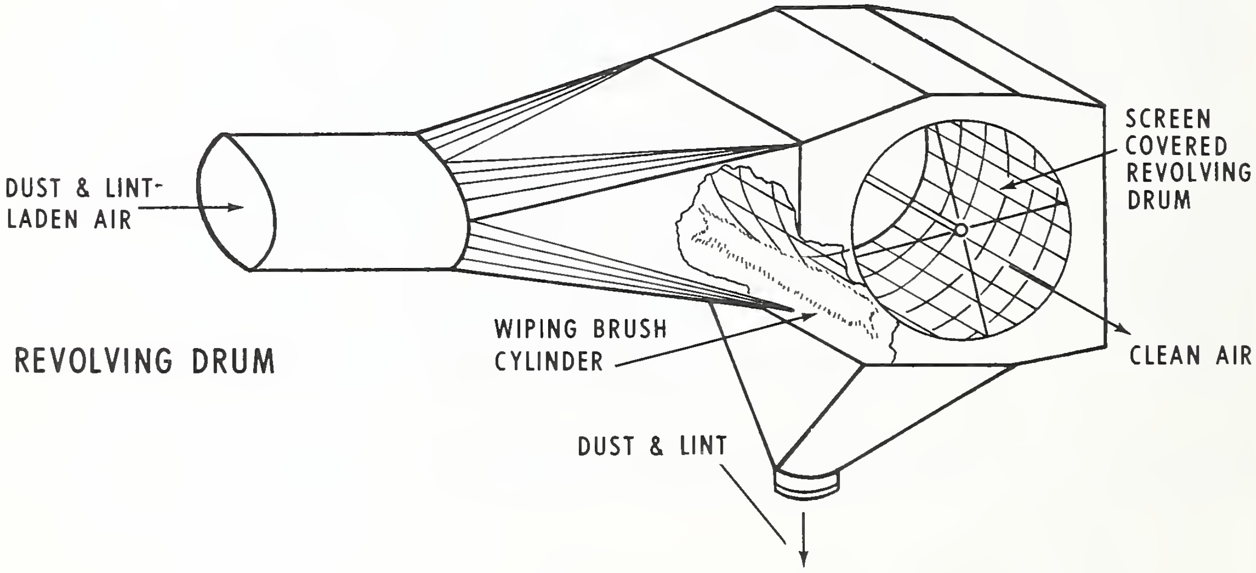

Figure A-5

FLAT SCREEN, ROUND, INLINE FILTER WITH RADIAL WIPING ARM

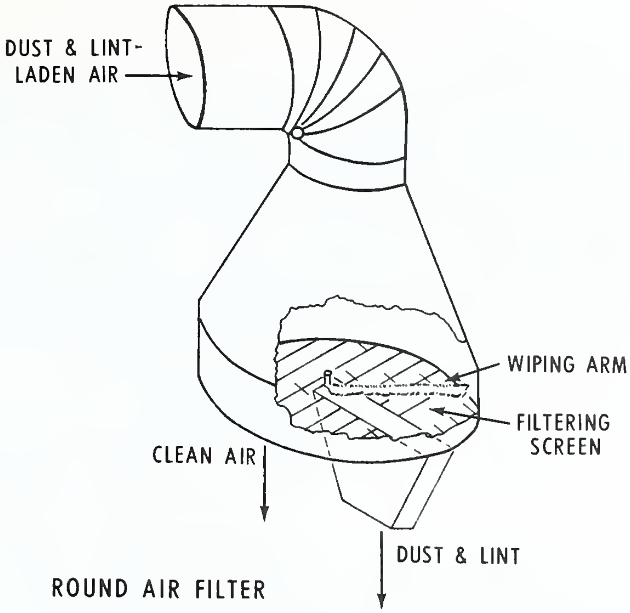

Figure A-6

INLINE AIR FILTER WITH AUTOMATIC STARTING AND STOPPING CLEANING SEQUENCE

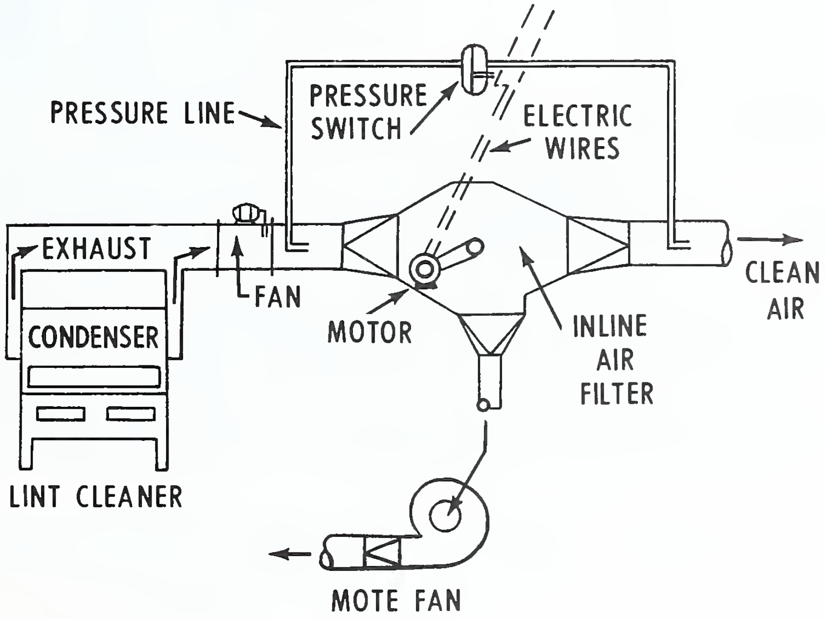

Figure A-7

Table A-2--Minimum dimensions for various condenser discharge volumes and various sizes of screen mesh for inline air filters with stationary screens and intermittent wiping action 1/

Condenser discharge ft^3/min	Exhaust pipe diameter	40-mesh cloth 2/		70-mesh cloth 3/		105-mesh cloth 4/	
		Radius	Width	Radius	Width	Radius	Width
	Inches						
Up to 3,000	18	20	18	20	18	20	22
3,000 to 5,000	18	20	22	20	28	20	36
5,000 to 7,000	18-26	20	30	24	32	24	42
7,000 to 9,000	18-28	24	32	24	42	28	48
9,000 to 11,000	21-28	24	40	26	46	32	50
11,000 to 13,000	26-28	26	44	28	50	40	48
13,000 to 15,000	28-36	28	46	32	52	40	54
15,000 to 20,000	28-42	32	54	40	54	40	72
20,000 to 30,000	36-42	40	64	44	74	48	90

1/ Anderson, D. M.,, and Baker, R.V. An Inline Air Filter for Collecting Gin Condenser Air Pollutants, ARS 42-103, U.S. Dept. Agr., Agr. Res. Serv., Sept. 1964.

2/ Size 40-mesh based on 1,280 ft/min face velocity, or approximately 0.1 inch of water pressure drop through screen.

3/ Size 70-mesh based on 1,000 ft/min face velocity, or approximately 0.1 inch of water pressure drop through screen.

4/ Size 105-mesh based on 750 ft/min face velocity of approximately 0.1 inch of water pressure drop through screen.

Condenser Coverings

Studies by the USDA Ginning Research Laboratory indicate lint fly can be controlled with no measurable adverse effects on grade, staple, or spinning performance (app. table 3). [4] This can be accomplished by (1) using fine screen wire to cover the standard condenser drum or (2) replacing the standard drum covering with perforated metal with openings smaller than those in the standard covering (app. fig. 8). These modifications may be made, either by the manufacturer or by sheet metal shops, to condensers already installed in gins. Such coverings will not prevent dust from passing into the atmosphere. Consequently, in areas where dust emission from condensers is not objectionable or prohibited, this more economical condenser covering may be installed in lieu of inline air filters.

STANDARD CONDENSER DRUM COVERING OVERLAID WITH FINE SCREEN, OR REPLACED WITH FINE PERFORATED METAL

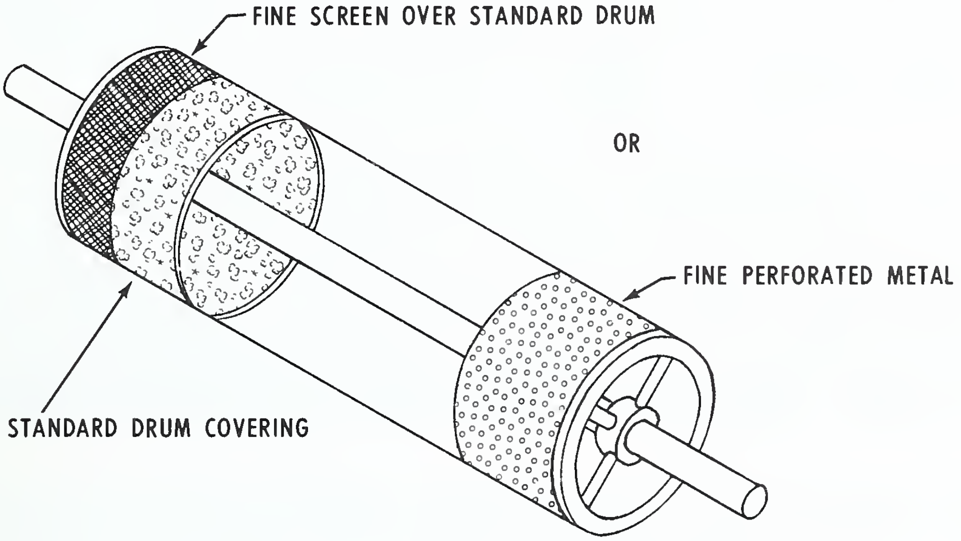

Figure A-8

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[4] McCaskill, Oliver L., and Moore, Vernon P. Elimination of Lint Fly. The Cotton Gin and Oil Mill Press, Dec. 31, 1966.

Table A-3--Dust and lint fly concentration from a unit lint cleaner condenser exhaust

Type drum covering and hole diameter	Number of holes	Open area	Ginning rate	Lint fly and dust concentration
	Per sq. in.	Percent	Bales/hr.	Grains/ 100 cu. ft.
Perforated metal 0.109" diam. (Standard)	47	45	1.4	50.8
Perforated metal 0.075" diam.	72	32	1.5	46.0
Perforated metal 0.033" diam.	234	20	1.5	32.0
Perforated metal 0.020" diam.	625	20	1.4	26.8
100 x 100 mesh screen over standard drum	0.0056" between mesh	1/ 14	1.4	21.6

1/ Standard drum open area is 45 percent and 100 x 100 mesh screen open area is 31.4 percent, making the final open area 14 percent.

Storage Facilities

Cyclone collectors and inline filters must be connected to adequate trash storage to efficiently remove residue collected in the ginning operation and facilitate its disposal.

Where space is not a limiting factor, and where the gin is located in a sparsely inhabited area, gin trash may be accumulated in an open pile and hauled away at the end of the season, or at the ginner's convenience. In less sparsely populated areas, it may be collected in a truck or trailer and hauled away as a load accumulates. The hauling conveyance should be parked in an enclosure designed to prevent the residue from blowing or scattering over the premises while it is accumulating.

Where larger volumes of residue are being handled within short periods of time, elevated storage hoppers are recommended. The hauling conveyance is positioned beneath the structure to receive the contents when the hopper doors are opened. Hopper capacities and arrangements will vary to incorporate maximum efficiencies into ginning systems. A rule of thumb is 20-foot-long hoppers with four sets of collectors for ginning rates up to 8 bales per hour. Thirty-foot-long hoppers, or longer, are recommended for ginning rates over 8 bales per hour. The design must consider size of the residue collection system, ginning rate, harvesting method used for cotton being ginned, design criteria of the collection devices, and number of air discharges being conveyed into the hopper. The use of screw conveyors is recommended to remove material from a battery of cyclones. Screw conveyor specifications must be consistent with discharge capacities to prevent residue from collecting in the cones of the cyclones.

The bases of trash hoppers may be enclosed, either on two sides or on all four, to achieve maximum control when the material is dumped into the hauling conveyance. However, this area should be left as open as possible, consistent with the degree of retention of trash that is necessary to provide for maximum efficiency. Cyclones may be erected on top of trash hoppers, or at a lower level, when the discharges are combined into one line and conveyed to a single cyclone arrangement on top of the trash hopper (app. fig. 9).

Air Handling Specifications for Cotton Gins

The number of fans required and the amount of air moved during ginning varies with the size of the plant and, to a lesser degree, with the method of harvest. The number of fans also depends on the types of equipment used and their arrangements in the ginning sequence. Specifications for a series of model gins with recommended layouts for both machine-picked and stripped cotton have been developed. 5/ These plants range in capacity from 6 to 36 bales per hour.

The amount of air moved per fan by high-pressure fans handling seed cotton and trash ranges from 2,000 to 11,000 ft^3/min (app. tables 4 and 5). The number of fans required varies from 8 in the 6-bale per hour plant designed for machine-picked cotton to 14 in the 36-bale plant for machine-stripped cotton. Since machine-stripped cotton has more foreign matter to be removed, a greater amount of seed cotton is needed for a 500-pound bale of lint. Therefore, gins designed to handle stripper-harvested cotton require more air and, consequently, more fans.

5/ Looney and Wilmot, op. cit., p. 17.

TYPICAL TRASH COLLECTING AND STORAGE SYSTEM

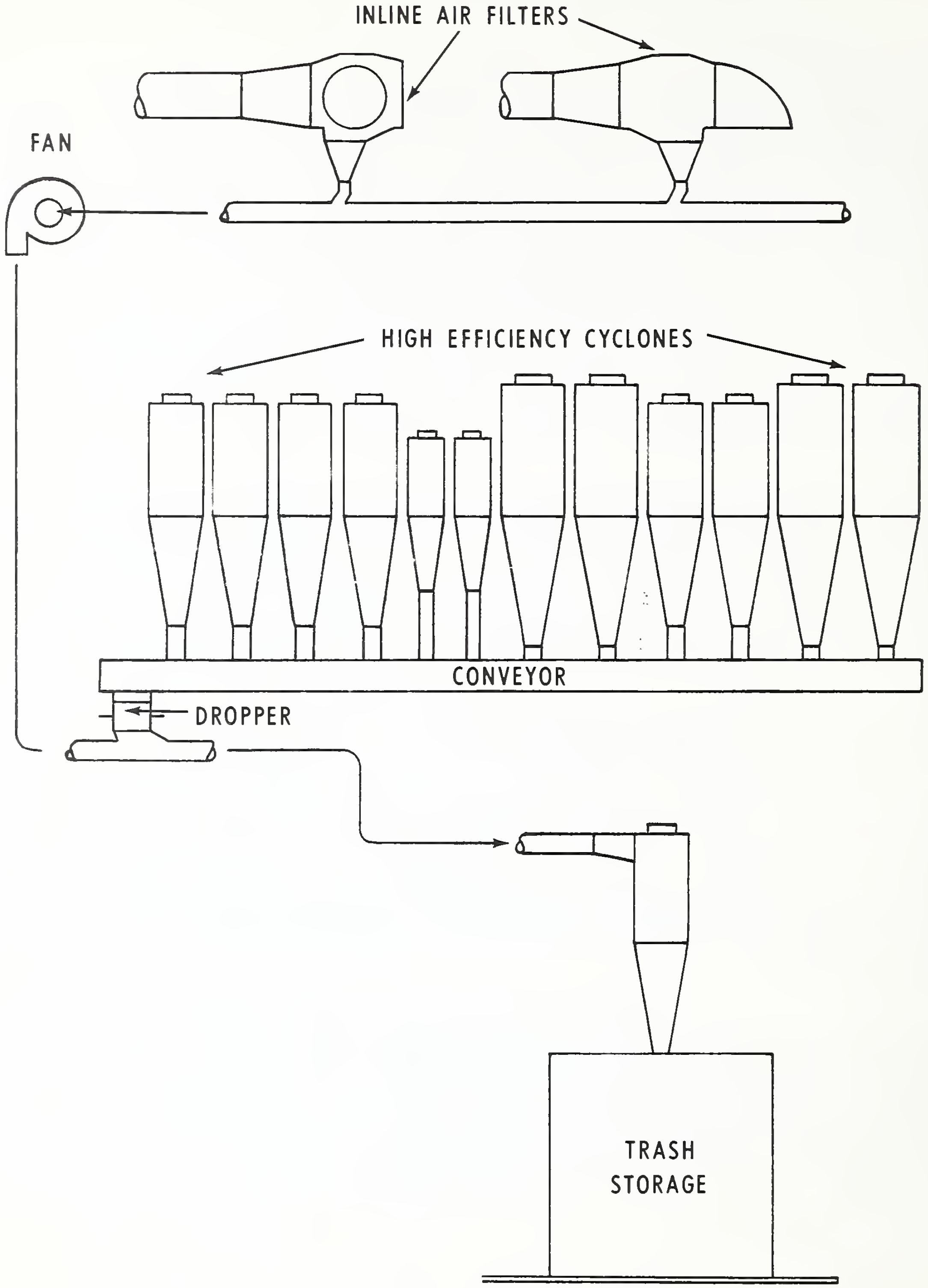

Figure A-9

Discharges from these fans, if uncontrolled, carry varying amounts of dust, trash particles, and lint into the atmosphere. The best method of reducing these pollutants to an acceptable level before the air is finally released is by installing an adequate number of properly sized, small-diameter cyclones.

Table A-4--Air volumes and cyclone and inline filter sizes by function for gin plants ranging in capacity from 6 to 36 bales per hour, machine-picked harvest areas

Function	Bale capacity per hour 1/									
	6		8		10		12		16	
	Air volume	Cyclone diameter or filter dimensions 2/	Air volume	Cyclone diameter or filter dimensions 2/	Air volume	Cyclone diameter or filter dimensions 2/	Air volume	Cyclone diameter or filter dimensions 2/	Air volume	Cyclone diameter or filter dimensions 2/
	Ft^3/min	Inches	Ft^3/min	Inches	Ft^3/min	Inches	Ft^3/min	Inches	Ft^3/min	Inches
Unloading	4,500	D-31	4,500	D-31	6,000	D-34	6,000	D-34	7,000	Q-26
Pull fan (No. 1 cleaner)	5,000	D-31	5,000	D-31	5,000	D-31	6,000	D-34	5,000 (2)	D-31 (2)
Pull fan (No. 2 cleaner)	5,000	D-31	5,000	D-31	5,000	D-31	6,000	D-34	5,000 (2)	D-31 (2)
Live overflow fan	2,500	S-32	2,500	S-32	3,500	D-28	3,500	D-28	4,500	D-31
Trash fan (feeders & gin stands)	2,500	S-32	2,500	S-32	3,500	D-28	3,500	D-28	4,500	D-31
Lint cleaning:										
1st stage mote fan	2,000	S-28	2,500	S-32	3,000	S-34	3,500	D-28	4,000	D-28
2nd stage mote fan	2,000	S-28	2,500	S-32	3,000	S-34	3,500	D-28	4,000	D-28
Trash dump fan	3,000	S-34	3,000	S-34	4,000	D-28	4,000	D-28	5,000	D-31
Lint cleaner exhaust vane-axial fan 3/	10,000	R-26, W-46	7,000 (2)	R-24, W-42 (2)	10,000 (2)	R-26,W-46 (2)	10,000 (2)	R-26, W-46 (2)	7,000 (4)	R-24, W-42 (4)
Condenser exhaust vane-axial fan	6,000	R-24, W-32	8,000	R-24, W-42	10,000	R-26, W-46	12,000	R-28, W-50	14,000	R-32, W-52

Continued

Table A-4--Air volumes and cyclone and inline filter sizes by function for gin plants ranging in capacity from 6 to 36 bales per hour, machine-picked harvest areas--Continued

Function	Bale capacity per hour 1/									
	18		20		24		30		36	
	Air volume	Cyclone diameter or filter dimensions2/	Air volume	Cyclone diameter or filter dimensions2/	Air volume	Cyclone diameter or filter dimensions2/	Air volume	Cyclone diameter or filter dimensions2/	Air volume	Cyclone diameter or filter dimensions2/
	Ft^3/min	Inches	Ft^3/min	Inches	Ft^3/min	Inches	Ft^3/min	Inches	Ft^3/min	Inches
Unloading...............	9,000	Q-29	9,000	Q-29	12,000	Q-34	9,000 (2)	Q-29 (2)	11,000 (2)	Q-32 (2)
Pull fan (No. 1 cleaner)	5,000 (2)	D-31 (2)	5,000 (2)	D-31 (2)	6,000 (2)	D-34 (2)	7,500 (2)	Q-28 (2)	9,000 (2)	Q-29 (2)
Pull fan (No. 2 cleaner)	5,000 (2)	D-31 (2)	5,000 (2)	D-31 (2)	6,000 (2)	D-34 (2)	7,500 (2)	Q-28 (2)	9,000 (2)	Q-29 (2)
Live overflow fan.......	4,500	D-31	5,000	D-31	5,000	D-31	6,500	Q-26	4,500 (2)	D-31 (2)
Trash fan (feeders & gin stands)...........	4,500	D-31	5,000	D-31	5,000	D-31	6,500	Q-26	8,000	Q-28
Lint cleaning:										
1st stage mote fan....	4,000	D-28	4,500	D-31	4,500	D-31	5,000	D-31	6,000	D-34
2nd stage mote fan....	4,000	D-28	4,500	D-31	4,500	D-31	5,000	D-31	6,000	D-34
Trash dump fan..........	5,000	D-31	6,000	D-34	6,000	D-34	7,000	Q-26	8,000	Q-28
Lint cleaner exhaust vane-axial fan 3/.....	10,000 (3)	R-26, W-46 (3)	10,000 (4)	R-26, W-46 (4)	10,000 (4)	R-26, W-46 (4)	10,000 (5)	R-26, W-46 (5)	10,000 (6)	R-26, W-46 (6)
Condenser exhaust vane-axial fan........	15,000	R-32, W-52	16,000	R-40, W-54	20,000	R-44, W-74	25,000	R-44, W-74	30,000	R-44, W-74

1/ Peak operating capacity.

2/ Vane-axial fans exhaust into air line filters. Other fans exhaust into cyclones. For air line filers, R = radius and W = width. For cyclones, S = single, D = double, and Q = quadruple. The numbers in parentheses indicate number of units.

3/ One fan and filter for each gin stand.

Table A-5--Air volumes and cyclone and inline filter sizes by function for gin plants ranging in capacity from 6 to 36 bales per hour, machine-stripped harvest areas

Function	Bale capacity per hour 1/									
	6		8		10		12		16	
	Air volume	Cyclone diameter or filter dimensions 2/	Air volume	Cyclone diameter or filter dimensions 2/	Air volume	Cyclone diameter or filter dimensions 2/	Air volume	Cyclone diameter or filter dimensions 2/	Air volume	Cyclone diameter or filter dimensions 2/
	Ft^3/min	Inches	Ft^3/min	Inches	Ft^3/min	Inches	Ft^3/min	Inches	Ft^3/min	Inches
Unloading	4,500	D-31	6,000	D-34	7,000	Q-26	7,000	Q-26	6,000 (2)	D-34 (2)
Pull fan (No. 1 cleaner)	5,000	D-31	5,000	D-31	5,000	D-31	6,000	D-34	5,000 (2)	D-31 (2)
Pull fan (No. 2 cleaner)	5,000	D-31	5,000	D-31	5,000	D-31	6,000	D-34	5,000 (2)	D-31 (2)
Live overflow fan	2,500	S-34	2,500	S-32	3,500	D-28	3,500	D-28	4,500	D-31
Trash fan (feeders & gin stands)	2,500	S-34	2,500	S-32	3,500	D-28	3,500	D-28	4,500	D-31
Trash fan (bur machine & airline)	3,500	D-28	3,500	D-28	4,500	D-31	5,000	D-31	3,500 (2)	D-28 (2)
Lint cleaning:										
1st stage mote fan	2,000	S-28	2,500	S-32	3,000	S-34	3,500	D-28	4,000	D-28
2nd stage mote fan	2,000	S-28	2,500	S-32	3,000	S-34	3,500	D-28	4,000	D-28
Trash dump fan	4,000	D-28	4,000	D-28	5,000	D-31	6,000	D-34	7,000	Q-26
Lint cleaner exhaust vane-axial fan 3/	10,000	R-26, W-46	7,000 (2)	R-24, W-42 (2)	10,000 (2)	R-26, W-46 (2)	10,000 (2)	R-26, W-46 (2)	7,000 (4)	R-24, W-42 (4)
Condenser exhaust vane-axial fan	6,000	R-24, W-32	8,000	R-24, W-42	10,000	R-26, W-46	12,000	R-28, W-50	14,000	R-32, W-52

Continued

Table A-5--Air volumes and cyclone and inline filter sizes, by function, for gin plants ranging in capacity from 6 to 36 bales per hour, machine-stripped harvest areas--Continued

Function	Bale capacity per hour 1/									
	18		20		24		30		36	
	Air volume	Cyclone diameter or filter dimensions 2/	Air volume	Cyclone diameter or filter dimensions 2/	Air volume	Cyclone diameter or filter dimensions 2/	Air volume	Cyclone diameter or filter dimensions 2/	Air volume	Cyclone diameter or filter dimensions 2/
	Ft^3/min	Inches	Ft^3/min	Inches	Ft^3/min	Inches	Ft^3/min	Inches	Ft^3/min	Inches
Unloading..............	6,000 (2)	D-34 (2)	6,000 (2)	D-34 (2)	7,000 (2)	Q-26 (2)	9,000 (2)	Q-29 (2)	11,000 (2)	Q-32 (2)
Pull fan (No. 1 cleaner)	5,000 (2)	D-31 (2)	5,000 (2)	D-31 (2)	6,000 (2)	D-34 (2)	7,500 (2)	Q-28 (2)	9,000 (2)	Q-29 (2)
Pull fan (No. 2 cleaner)	5,000 (2)	D-31 (2)	5,000 (2)	D-31 (2)	6,000 (2)	D-34 (2)	7,500 (2)	Q-28 (2)	9,000 (2)	Q-29 (2)
Live overflow fan.......	4,500	D-31	5,000	D-31	5,000	D-31	6,500	Q-26	4,500 (2)	D-31 (2)
Trash fan (feeders & gin stands)...........	4,500	D-31	5,000	D-31	5,000	D-31	6,500	Q-26	8,000	Q-28
Trash fan (bur machine & air line)...........	3,500 (2)	D-28 (2)	4,000 (2)	D-28 (2)	4,000 (2)	D-28 (2)	4,500 (2)	D-31 (2)	4,500 (2)	D-31 (2)
Lint cleaning:										
1st stage mote fan....	4,000	D-28	4,500	D-31	4,500	D-31	5,000	D-31	6,000	D-34
2nd stage mote fan....	4,000	D-28	4,500	D-31	4,500	D-31	5,000	D-31	6,000	D-34
Trash dump fan..........	7,000	Q-26	8,000	Q-28	8,000	Q-28	10,000	Q-31	10,000	Q-31
Lint cleaner exhaust vane-axial fan 3/......	10,000 (3)	R-26, W-46 (3)	10,000 (4)	R-26, W-46 (4)	10,000 (4)	R-26, W-46 (4)	10,000 (5)	R-26, W-46 (5)	10,000 (6)	R-26, W-46 (6)
Condenser exhaust vane-axial fan........	15,000	R-32, W-52	16,000	R-40, W-54	20,000	R-40, W-54	25,000	R-44, W-74	30,000	R-44, W-74

1/ Peak operating capacity.

2/ Vane-axial fans exhaust into air line filters. Other fans exhaust into cyclones. For air line filters, R = radius and W = width. For cyclones, S = single, D = double, and Q = quadruple. The numbers in parentheses indicate number of units.

3/ One fan and filter for each gin stand.

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